Applicant(s):Eitan Bachmat, Tao Kai Lam and Ruben Michel
Serial No.:   09/541,159
Filed: March 31, 2000

In the Claims

Please amend claims 1, 8, 9, 11, 15 through 17 and 19 and
cancel claims 2 through 7, 10 and 11 as follows:

1 (amended).   A method for determining a seek time required
for moving a disk head between first and second addresses on a
physical disk drive including multiple logical volumes, said
method comprising the steps of:

A)   dividing the disk into a plurality of segments, each
segment having a given size and being defined by
first and second boundaries of a plurality of
contiguous tracks,

B)   establishing an array of actual seek times for seek
operations between each segment pair based upon the
first and second boundaries,

C)   generating a seek time for disk head movement between
the first and second addresses by linearly
interpolating the array of actual seek times based
upon the first and second addresses, said
interpolation being based on a Ratio Theorem analysis
using a center location of each segment as the
reference location for disk seek operations between
different logical volumes.

2-7 (canceled).

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8 (amended). A method as recited in claim [[6]]1 wherein [the physical disk drive includes a data block and] said interpolation uses the boundaries of [the data block]a logical volume to obtain a disk seek time for seek operations within the [data block]logical volume.

9 (twice amended). A method for determining the seek time over a time interval for a physical disk drive configured to store data in a plurality of logical volumes[over a time interval], said method comprising the steps of:

A) dividing the physical disk into a plurality of fixed sized segments independently of the logical volume configuration on the physical disk drive wherein each segment has a plurality of contiguous tracks,

B) determining actual seek times for seek operations between the segments by,

    i) assigning a predetermined seek time for each seek operation between two segment boundaries,

    ii) calculating an intrasegment seek time based upon the predetermined seek times, and

    iii) placing the predetermined seek times in a two-dimensional array with the rows and columns defined by the segment boundaries.

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C)   accumulating statistics for each access to each

logical volume during the time interval,

D)   converting the accumulated statistics into an

estimated number of seeks between each pair of

logical volumes,

E)   defining a seek time for each logical volume pair

based upon said actual segment seek times, and

F)   generating a total seek time as the sum of the

products, for each logical volume pair, of the actual

seek time for and the estimated number of seeks

between each logical volume in the logical volume

pair over the time interval.

10 and 11(canceled).

12 (previously presented). A method as recited in claim 9
wherein said accumulation of statistics includes segregating
each access to a logical volume into one of predetermined
classes of accesses and weighting the numbers of accesses in
each predetermined class.

13 (previously presented). A method as recited in claim 12
wherein said segregation of accesses is into one of random
read, write and sequential prefetch read classes with
weightings of 1.0, 0.5 and 0.25, respectively.

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14 (previously presented). A method as recited in claim 13
wherein A_i and A_j represent the weighted access to logical
volumes i and j, and A represents the weighted sum of all the
accesses to the physical disk drive and wherein the estimated
number of disk accesses for the logical volume pair being given
by:

$$Nr\ seeks(i,j) = \frac{A_i A_j}{A}$$

15 (amended). A method as recited in claim 9 wherein said
[definition]determination of each actual seek time comprises
determining the seek time between a center location of each of
the logical volumes in the logical volume pair.

16 (amended). A method as recited in claim 15 wherein said
[definition]determination of each actual seek time includes
interpolating the seek times determined for seek operations
between the segments based upon the center locations.

17 (amended). A method as recited in claim 15 wherein said
[definition]determination of each actual seek time includes
the step of linearly interpolating the seek times determined
for seek operations between the segments based upon the center
locations.

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18 (previously presented). A method as recited in claim 15
wherein A_i and A_j represent the weighted access to logical
volumes i and j, respectively, and A represents the weighted
sum of all the accesses to the physical disk drive and wherein
the estimated seek time for the logical volume pair is given
by:

$$Seek\ time\ (i,j) = t_{i,j}\ \frac{A_i A_j}{A}$$

19 (amended). A method as recited in claim 9 additionally
comprising the step of determining an intravolume [the time for
a]seek [operation]time within a logical volume.

20 (previously presented). A method as recited in claim 19
wherein said determination of intravolume seek time for a
logical volume includes defining the boundaries of the logical
volume relative to the segment boundaries and determining the
seek time between the logical volume boundaries.

21 (previously presented). A method as recited in claim 20
wherein said definition of intravolume seek time includes
interpolating the seek times determined for seek operations
between the segments based upon the logical volume boundary
locations.

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22 (previously presented). A method as recited in claim 20 wherein said definition of seek time includes the step of linearly interpolating the seek times determined for seek operations between the segments based upon the logical volume boundary locations.

23 (previously presented). A method for determining the seek time over a time interval for a physical disk drive configured to store data in a plurality of logical volumes, said method comprising the steps of:

A) dividing the physical disk into a plurality of fixed sized segments characterized by boundaries independently of the logical volume configuration on the physical disk drive,

B) determining seek times for seek operations between the segments by assigning empirically derived seek times between two segment boundaries,

C) accumulating statistics for each access to each logical volume during the time interval,

D) converting the accumulated statistics into an estimated number of seeks between each pair of logical volumes by weighting the numbers of accesses in each of different predetermined classes,

E) defining a seek time for each logical volume pair based upon said segment seek times by using the

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center locations of each logical volume to

interpolate the seek times determined for seek

operations between the segments, and

F) generating a total seek time that is the sum of the

seek times for each logical volume pair obtained as a

function of the estimated number of seeks and the

defined seek time for the logical volume pair.

24 (previously presented).   A method as recited in claim 23

wherein each of said center locations is given as an offset

from a segment boundary according to:

$$p = x - \lfloor x \rfloor$$

and

$$q = \lceil y \rceil - y$$

where x and y represent center line locations of logical

volumes, $\lfloor x \rfloor$ and $\lceil y \rceil$ represent "floor of x" and "ceiling of y"

functions for the values of x and y based upon the boundaries

of the segments and p and q represent the displacements of the

center line addresses for each logical volume relative to a

segment boundary.

25 (previously presented).   A method as recited in claim 24

wherein said definition of seek time for each logical volume

includes the step of generating a seek time according to:

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$$t_{i,j} = pq \ time(\lfloor x \rfloor + 1, \lceil y \rceil - 1)$$

$$+ p(1-q) \ time(\lfloor x \rfloor + 1, \lceil y \rceil)$$

$$+ (1-p)q \ time(\lfloor x \rfloor, \lceil y \rceil - 1)$$

$$+ (1-p)(1-q) \ time(\lfloor x \rfloor, \lceil y \rceil)$$

where t_{ij} represents the seek time for a specific pair of logical volumes and *time* is the seek interval for the corresponding relationship.

26 (previously presented). A method for determining the seek time over a time interval for a logical volume on a physical disk drive configured to store data in at least one logical volume, said method comprising the steps of:

A) dividing the physical disk into a plurality of fixed sized segments independently of the logical volume configuration on the physical disk drive,

B) determining seek times for seek operations between the segments by assigning empirically derived seek times between two segment boundaries,

C) accumulating statistics for each access to the logical volume during the time interval,

D) converting the accumulated statistics into an estimated number of seeks between locations within

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the logical volume by weighting the numbers of

accesses in each of different predetermined classes,

E)   defining a seek time for the logical volume pair

based upon said segment seek times by using the

boundary locations of the logical volume to

interpolate the seek times determined for seek

operations between the segments, and

F)   generating a total logical volume seek time that

depends upon the number of accesses to the logical

volume and the seek times between the boundary

locations for the logical volume.

27 (previously presented).   A method as recited in claim 26

wherein each of the boundary locations is given as an offset

from a segment boundary according to:

$$p = x - \lfloor x \rfloor$$

and

$$q = \lceil y \rceil - y$$

where x and y represent center line locations of logical

volumes, $\lfloor x \rfloor$ and $\lceil y \rceil$ represent "floor of x" and "ceiling of y"

functions for the values of x and y based upon the boundaries

of the segments and p and q represent the displacements of the

center line addresses for each logical volume relative to a

segment boundary.

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28 (previously presented).   A method as recited in claim 27 wherein said definition of seek time for intravolume seeks includes the step of generating a seek time according to:

$$t_{i,j} = pq \ time(\lfloor x \rfloor + 1, \lceil y \rceil - 1)$$

$$+ p(1-q) \ time(\lfloor x \rfloor + 1, \lceil y \rceil)$$

$$+ (1-p)q \ time(\lfloor x \rfloor, \lceil y \rceil - 1)$$

$$+ (1-p)(1-q) \ time(\lfloor x \rfloor, \lceil y \rceil)$$

where t_{ij} represents the seek time for a specific pair of logical volumes and time is the seek interval for the corresponding relationship.

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